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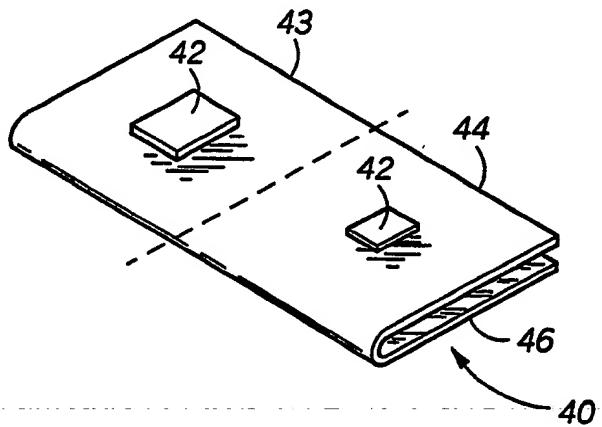
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(54) Title: PRINTED CIRCUIT BOARD HAVING MULTIPLE FORM FACTORS



(57) Abstract

A printed circuit board (40) may be selectively positioned in one of a plurality of shapes for inclusion within a housing (20) for a device such as a pager, wherein the housing has been manufactured in any one of a plurality of shapes or forms.

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## PRINTED CIRCUIT BOARD HAVING MULTIPLE FORM FACTORS

## Field of the Invention

5 This invention relates in general to printed circuit boards, and more specifically, a printed circuit board that may be selectively positioned in one of a plurality of shapes for inclusion within a housing for a device such as a pager that may be manufactured in many forms.

## 10 Background of the Invention

Printed circuit boards conventionally have comprised a flat, rectangular, rigid or flexible material on which various electronic circuit elements, i.e., transistors, resistors, and capacitors, are placed. Electrical connections between these circuit elements are made by metal flows on the printed circuit board or by wire directly between the circuit elements.

15 Electronic system devices, such as selective call receivers including pagers, typically are manufactured in many different shapes to fulfill different user requirements. For example, pagers are manufactured in the  
20 approximate shape of a cigarette pack for attachment to a belt, in the shape of a pen for attachment to a shirt pocket, or in the shape of a credit card for insertion into a shirt pocket. Each of these different shaped pagers typically require substantially the same components, i. e., speaker, battery, antenna, switches, printed circuit board for the electronic circuit elements, and a  
25 display device. Because of the different shape and size of each of these pagers, the printed circuit board for each pager was manufactured with a different shape. A credit card pager could use a flat rectangular printed circuit board; however, a pen shaped pager may require a narrower but longer printed circuit board. Therefore, even though the printed circuit  
30 boards for each of these shapes may have identical electronic circuitry, each printed circuit board would have to be manufactured differently.

Thus, what is needed is a printed circuit board that may be placed within any one of a plurality of pagers having defined shapes by selectively changing the overall shape of the printed circuit board after manufacture.

## **Summary of the Invention**

Accordingly, it is an object of the present invention to provide an improved printed circuit board.

5 Another object of the present invention is to provide a printed circuit board whose shape may be selected after manufacture in order to be placed within a variety of shaped electronic system housings.

In carrying out the above and other objects of the invention in one form, there is provided a selective call receiver selectively housed within one of two or more housings, wherein each of the two or more housings have one of a plurality of shapes. A printed circuit material is capable of assuming at least two of the plurality of shapes corresponding to the shape of the two or more housings. The printed circuit material is engageably positioned within the housing and is coupled to a battery, antenna, and to an alert device that may be attached to the housing.

The above and other objects, features, and advantages of the present invention will be better understood from the following detailed description taken in conjunction with the accompanying drawings.

## **20 Brief Description of the Drawing**

FIGS. 1 A and B are side and top views, respectively, of one type of a pager.

FIGS. 2 A and B are side and top views, respectively, of a second type of  
25 a pager.

FIGS. 3 A and B are side and top views, respectively, of a third type of a pager.

FIGS. 4 A and B are side and top views, respectively, of a fourth type of a pager.

30 FIGS. 5 A and B are side and top views, respectively, of a fifth type of a  
pager.

**FIG. 6** is a block diagram of the components of a typical pager.

FIG. 7 is a perspective view of a first embodiment of the present invention.

FIG. 8 is a perspective view of the first embodiment folded so as to fit within the pager of FIG. 4.

FIG. 9 is a perspective view of the first embodiment folded so as to fit within the pager of FIGS. 1 or 2.

5 FIG. 10 is a perspective view of the first embodiment folded so as to fit within the pager of FIG. 5.

FIG. 11 is a perspective view of a second embodiment of the present invention.

10 FIG. 12 is a perspective view of the second embodiment folded so as to fit within the pager of FIG. 5.

#### Detailed Description of the Invention

Referring to FIGs. 1A and 1B through 5A and 5B, side and top views of  
15 a variety of selective call radio receivers, such as pagers, are illustrated. Each pager comprises a housing 20; switches 21 for controlling power, type of alert, volume of alert, etc.; and ports 22 for emitting an audible alert or audible message. The pagers shown in FIGs. 1, 2, and 4 further comprise a clip 23 for attaching the pager to an item of clothing such as a belt or a shirt pocket. The housing 20 of the pagers shown in FIGs. 1-5 each have a different shape or form factor for satisfying a particular user desire. The pager shown in FIG. 1 is in the shape of a rectangular box for attachment to a belt, for example. The pager shown in FIG. 2 is in the shape of an elongated rectangular box for attachment to the inside of a shirt pocket (pen shape).  
20  
25 The pager shown in FIG. 3 is in the shape of an credit card for placement within a pocket, billfold, or purse, for example. The pager shown in FIG. 4 is in the shape of a triangular box for attachment to a belt, for example. The pager shown in FIG. 5 is in the shape of an square box for placement on a desk, for example. Because of the different shapes of these pagers, internal  
30 components such as antennas, batteries, and printed circuit boards have different size and location requirements. For example, while a AAA battery may fit within the housing 20 of the belt pager of FIG. 1, it would be too bulky to fit within the credit card pager shown in FIG. 3 without creating a discontinuity in the external shape. This same size problem also exists with

the printed circuit boards. Even though the electronics of the previously known pagers were the same, the different shape of the housing required different printed circuit boards for each type of housing. The ability to use the same printed circuit board for the differently shaped pagers would be  
5 very cost effective.

Referring to FIG. 6, a block diagram of a typical pager comprises a printed circuit board 30 including a decoder section, a channel RF section, and an IF section. An antenna 31, a battery 32, an alert apparatus 33, and a control apparatus 34 such as on/off and volume control switches are  
10 electrically coupled to the circuit board for performing the pager operation well known to those skilled in the art. A display apparatus 35 may be included in the pager for visually displaying an alert or a message. For a more detailed description of the structure and operation of a selective call radio paging receiver of the type shown in FIG. 6, reference is made to U. S.  
15 Patent Number 4,518,961, issued May 21, 1985 and entitled "Universal Paging Device With Power Conservation"; U. S. Patent Number 4,649,583, issued March 10, 1987 and entitled "Radio Paging Device With Improved Test Modes"; and U. S. Patent Number 4,755,816, issued July 5, 1988 and entitled "Battery Saving Methods for Selective Radio Paging Receiver", the  
20 teachings of which are hereby incorporated by reference.

In accordance with the present invention and referring to FIG. 7, a printed circuit board 40 may comprise a rigid material (the rigid printed circuit board being well known in the art) or a flexible material such as kapton, and has fold regions 41 wherein the printed circuit board 40 may be  
25 folded to assume different shapes (form factors). Electronic devices 42 such as integrated circuits (chips), transistors, resistors, capacitors, and the like are placed on the printed circuit board 40 and electrically coupled for forming a circuit as disclosed in the above referenced patents. Alternatively, the printed circuit board 40 may be cut along regions 41 while maintaining  
30 electrical contact via flexible or non-flexible connectors.

By folding the printed circuit board 40 along one fold line 41, the shape illustrated in FIG. 8 will readily fit within the housing 20 of FIG. 4 and the shape illustrated in FIG. 9 will readily fit within the housing of FIGs. 1 and 2. The printed circuit board may be further folded along a second fold region 41

to provide the shape illustrated in FIG. 10 for inclusion in the housing 20 of FIG. 5. The same printed circuit board may be also partially folded along the first fold region 41 to provide the shape illustrated in FIG. 8 for inclusion in the housing 20 of FIG. 4. Functions external to the printed circuit board such

5 as the alert apparatus 33, antenna 31, display 35, battery 32 and control apparatus 34 typically are positioned on the housing in accordance with the shape of the housing. The printed circuit board 30 may be designed and/or the location of the external functions may be modified slightly so the connectors for each external function on the printed circuit board 30

10 matches the location of each external function. Alternatively, a flexible connector of a given length may be utilized to interconnect the printed circuit board with each external function for each shape of pager.

A second embodiment is shown in FIGs. 11 and 12 wherein the portions 43, 44, 45, and 46 are spaced apart but electrically and physically coupled by flexible flanges 47 comprising a flexible material such as kapton. The portions 43, 44, 45, and 46 may be folded once, or twice as shown in FIG. 12, for inclusion in differently shaped housing in a similar manner as discussed above.

By now it should be appreciated that there has been provided a printed circuit board that may be selectively positioned in one of a plurality of shapes for inclusion within a housing for a device such as a pager that may be manufactured in many forms.

## CLAIMS

1. A printed circuit material comprising:  
a first portion; and  
a second portion capable of being placed in any one of at least first  
and second positions relative to said first portion.  
5
2. The printed circuit material according to claim 1 wherein said  
printed circuit material comprises a flexible material, said flexible material  
being folded so as to place said second portion relative to said first portion.
3. The printed circuit material according to claim 2 wherein said  
flexible material comprises kapton.
4. The printed circuit material according to claim 1 further comprising  
third and fourth portions, each of said first, second, third, and fourth  
portions capable of being placed in any one of a plurality of positions  
relative to each other.  
5
5. The printed circuit material according to claim 4 wherein said  
printed circuit material comprises a flexible material, said flexible material  
being folded so as to place said first, second, third, and fourth portions  
relative to each other.
6. The printed circuit material according to claim 5 wherein said  
flexible material comprises kapton.
7. A printed circuit comprising:  
a first portion; and  
a second portion electrically coupled to said first portion and  
capable of occupying at least first and second positions with respect to said  
first portion so as to vary the shape of said printed circuit.  
5

8. The printed circuit material according to claim 7 wherein said printed circuit material comprises a flexible material, said flexible material being folded so as to place said second portion relative to said first portion.

9. The printed circuit material according to claim 8 wherein said flexible material comprises kapton.

10. The printed circuit material according to claim 7 further comprising third and fourth portions, each of said first, second, third, and fourth portions capable of being placed in any one of a plurality of positions relative to each other.

5

11. The printed circuit material according to claim 10 wherein said printed circuit material comprises a flexible material, said flexible material being folded so as to place said first, second, third, and fourth portions relative to each other.

5

12. The printed circuit material according to claim 11 wherein said flexible material comprises kapton.

13. A printed circuit material for placement within one of first and second housings of different shapes, comprising:

a first portion; and

a second portion capable of being selectively positioned with

5 respect to said first portion so as to be selectively housed in either one of said first and second housings.

14. The printed circuit material according to claim 13 wherein said printed circuit material comprises a flexible material, said flexible material being folded so as to place said second portion relative to said first portion.

15. The printed circuit material according to claim 14 wherein said flexible material comprises kapton.

16. The printed circuit material according to claim 13 further comprising third and fourth portions, each of said first, second, third, and fourth portions capable of being placed in any one of a plurality of positions relative to each other.

5

17. The printed circuit material according to claim 16 wherein said printed circuit material comprises a flexible material, said flexible material being folded so as to place said first, second, third, and fourth portions relative to each other.

5

18. The printed circuit material according to claim 17 wherein said flexible material comprises kapton.

19. A selective call receiver selectively housed within one of two or more housings, each of said two or more housings having one of a plurality of shapes, said selective call receiver comprising:

first means for alerting a user of an incoming message;

5 second means for providing a voltage; and

a printed circuit material coupled to said first and second means and engageably positioned within said housing, said printed circuit material capable of assuming at least two of said plurality of shapes corresponding to the shape of said two or more housings.

10

20. The selective call receiver according to claim 19 wherein said plurality of shapes comprises a credit card shape.

22. The selective call receiver according to claim 19 wherein said plurality of shapes comprises a pen shape.

22. The selective call receiver according to claim 19 wherein said plurality of shapes comprises a shape appropriate for attachment to a belt.

23. The selective call receiver according to claim 19 wherein said first and second means are attached to each of said two or more housings, said first and second means being positioned on each of said housings such that

said printed circuit material engages said first and second means when  
5 positioned within each of said housings.

24. The selective call receiver according to claim 19 wherein said first and second means are attached to each of said two or more housings, said selective call receiver further comprising:

a first flexible electrical contact coupled between said printed  
5 circuit material and said first means; and

a second flexible electrical contact coupled between said printed circuit material and said second means.

25. The selective call receiver according to claim 19 wherein said printed circuit material comprises at least first and second portions, wherein said portions are selectively positioned with respect to each other so as to be selectively housed in said two or more housings.

5 26. The selective call receiver according to claim 25 wherein said printed circuit material comprises a flexible material, said flexible material being folded so as to selectively place said portions with respect to each other.

5 27. The selective call receiver according to claim 26 wherein said flexible material comprises kapton.

28. A method for altering the shape of a printed circuit to allow the printed circuit to be housed in any one of at least first and second housings of different shapes, comprising positioning a first portion of the printed circuit with respect to a second portion of the printed circuit so as to 5 conform its shape to one of the first and second housings.

29. The method according to claim 28 further comprising the step of, prior to the positioning step, cutting the printed circuit so as to separate the first and second portions while maintaining electrical contact.

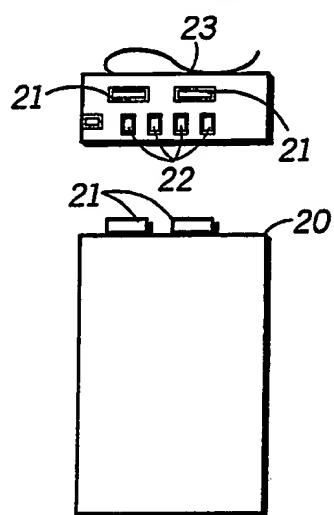
30. The method according to claim 28 wherein the positioning step comprises folding the printed circuit.

31. The method according to claim 28 further comprising positioning third and fourth portions of the printed circuit with respect to each other and to the first and second portions so as to conform its shape to one of the first and second housings.

5

32. The method according to claim 28 further comprising the step of, prior to both positioning steps, cutting the printed circuit so as to separate the first and second portions while maintaining electrical contact.

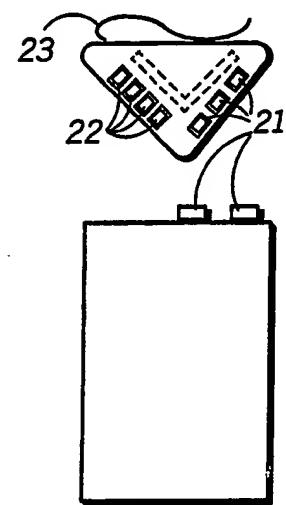
33. The method according to claim 28 wherein both positioning steps comprise folding the printed circuit.

**FIG.1B**

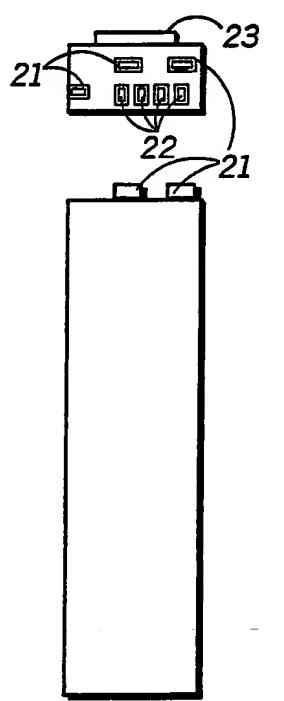
— PRIOR ART —

**FIG.1A**

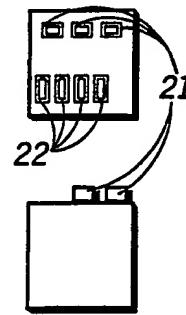
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**FIG.4B**

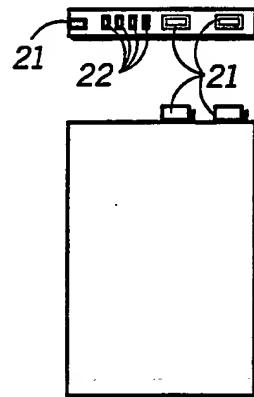
— PRIOR ART —

**FIG.4A****FIG.2B**

— PRIOR ART —

**FIG.2A****FIG.5B**

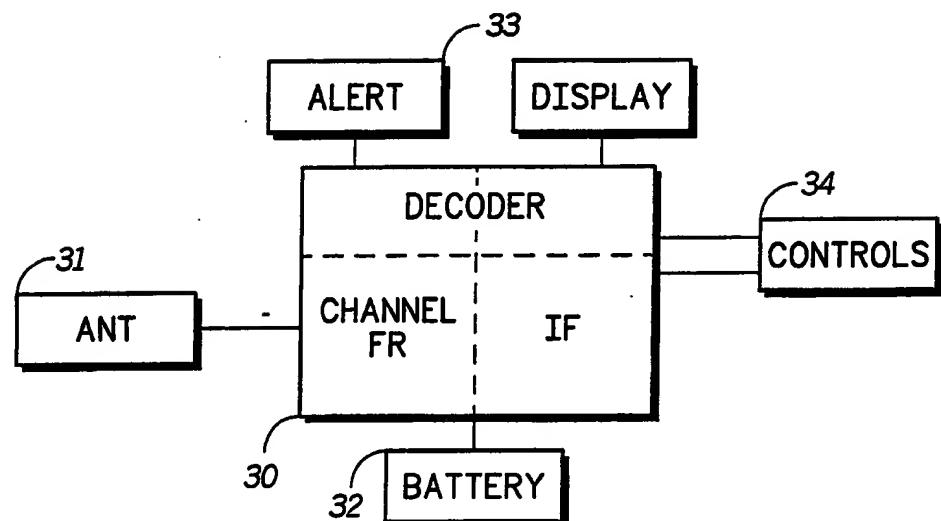
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**FIG.5A****FIG.3B**

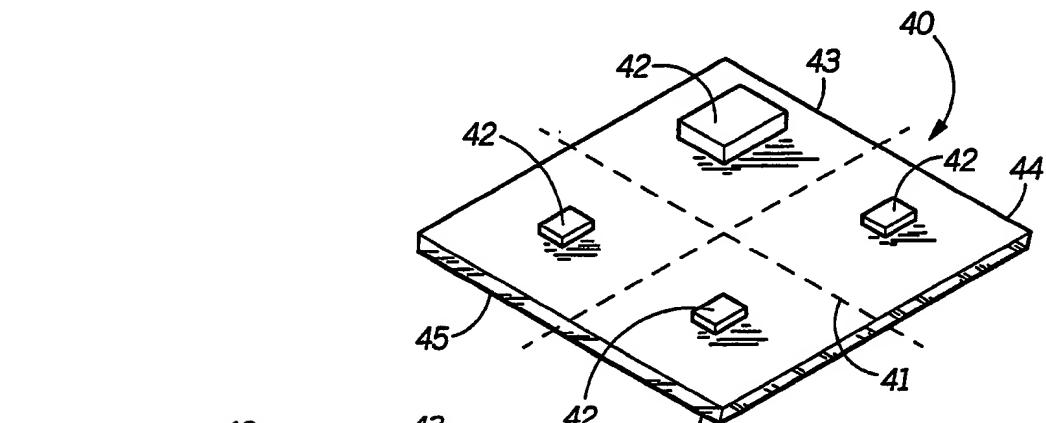
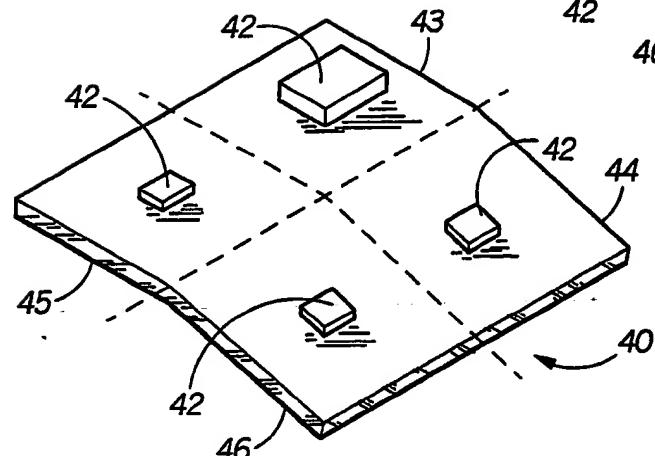
— PRIOR ART —

**FIG.3A**

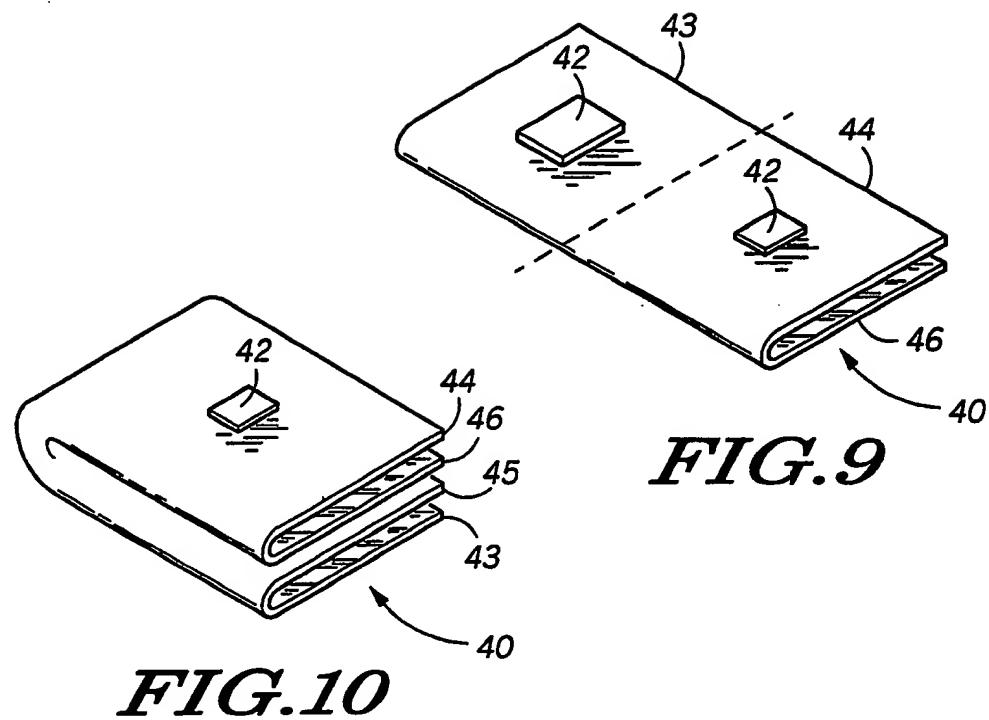
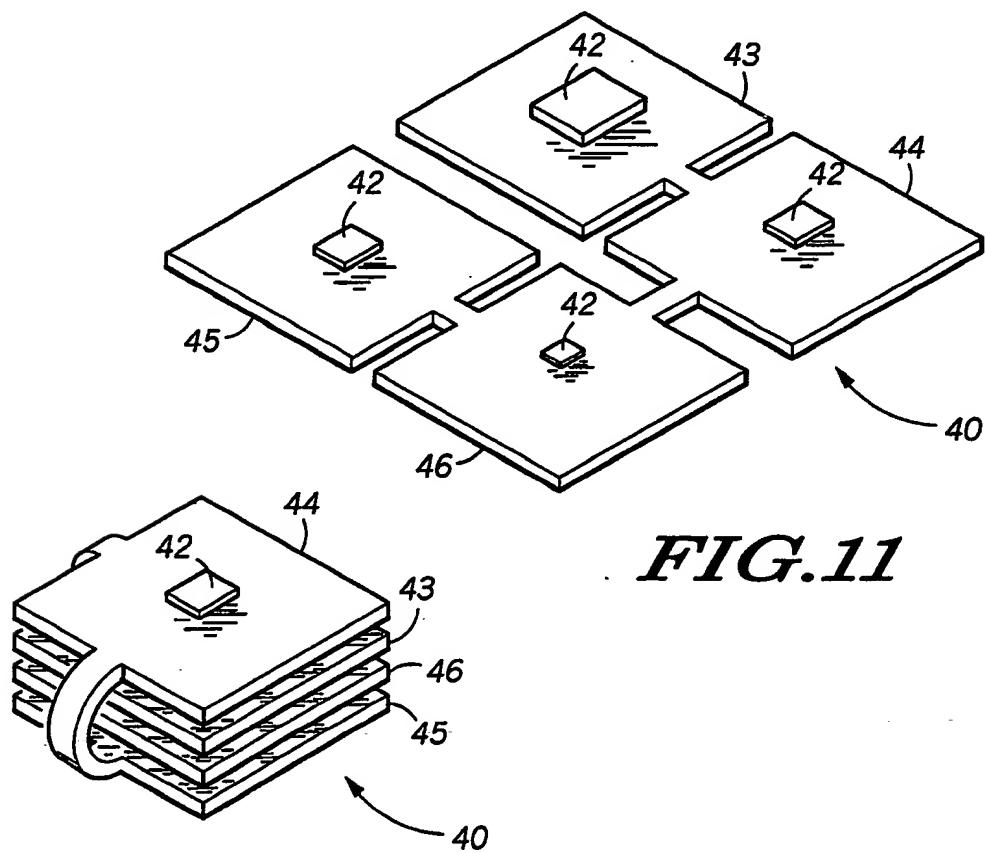
2/3



— PRIOR ART —

***FIG. 6******FIG. 7******FIG. 8***

3/3

**FIG. 9****FIG. 10****FIG. 11****FIG. 12**

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US90/01798

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) <sup>3</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

I.PC(5) H05K 1/00

U.S. Cl. 361/398

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>4</sup>

Classification System	Classification Symbols
29/829	361/398, 414, 424
U.S. Cl 340/825.44-825.48, 311.1	368/10, 82
341/23	439/67

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>14</sup>

Category <sup>6</sup>	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
Y	US,A, 3,805,213, Austin, 16 APRIL 1974 (see column 2, lines 32-37)	1-33
Y	US,A, 4,786,902, Davis et al., 22 NOVEMBER 1988 (see entire document)	19-27
Y	US,A, 4,792,879, Bauknecht et al., 20 DECEMBER 1988 (see entire document)	1-33
Y	FR,A, 2,344,203, Nicolas, 10 NOVEMBER 1977 (see entire document)	19-27

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search <sup>2</sup>

06 JUNE 1990

Date of Mailing of this International Search Report <sup>2</sup>

09 AUG 1990

International Searching Authority <sup>1</sup>

ISA/US

Signature of Authorized Officer <sup>10</sup> -

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